US009324236B2

(12) **United States Patent**
Estkowski et al.

(10) **Patent No.: US 9,324,236 B2**
(45) **Date of Patent: Apr. 26, 2016**

(54) **SYSTEM AND METHODS FOR SITUATION AWARENESS, ADVISORY, TRACKING, AND AIRCRAFT CONTROL INFORMATION**

(75) Inventors: **Regina I. Estkowski**, Bellevue, WA (US); **Ted Dell Whitley**, Lopez Island, WA (US); **Richard Baumeister**, Aurora, CO (US); **Graham Spence**, Huddersfield (GB)

(73) Assignee: **The Boeing Company**, Chicago, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 689 days.

(21) Appl. No.: **13/303,285**

(22) Filed: **Nov. 23, 2011**

(65) **Prior Publication Data**

US 2013/0126679 A1 May 23, 2013

(51) **Int. Cl.**
G08B 21/00 (2006.01)
G08G 5/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G08G 5/0013*** (2013.01); ***G08G 5/0021*** (2013.01); ***G08G 5/0078*** (2013.01); *G08G 5/0039* (2013.01); *G08G 5/0069* (2013.01); *G08G 5/0091* (2013.01)

(58) **Field of Classification Search**
CPC .. G08G 5/0013; G08G 5/0021; G08G 5/0078
USPC 340/945–950, 972–973, 340/995.11–995.19, 961, 964, 953
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,980,902 A * 4/1961 Tasker et al. 342/34
3,940,597 A * 2/1976 DiMatteo 701/518
4,274,096 A * 6/1981 Dennison 342/456
4,706,198 A 11/1987 Thurman
5,381,338 A 1/1995 Wysocki et al.
5,554,990 A * 9/1996 McKinney 342/36
5,890,079 A 3/1999 Levine
6,052,645 A * 4/2000 Harada 701/423
6,057,786 A * 5/2000 Briffe et al. 340/975
6,477,152 B1 * 11/2002 Hiett 370/316
6,501,392 B2 * 12/2002 Gremmert et al. 340/971
6,567,069 B1 * 5/2003 Bontrager et al. 345/156
6,633,259 B1 * 10/2003 Smith et al. 342/456
6,633,810 B1 * 10/2003 Qureshi et al. 701/467

(Continued)

FOREIGN PATENT DOCUMENTS

WO WO 2004105340 A1 * 12/2004 ..... H04L 29/06
WO WO 2008126126 A2 * 10/2008 ..... G08G 5/00

OTHER PUBLICATIONS

Extended European Search Report of Application No. 12193473; Dec. 3, 2013; 8 pages.

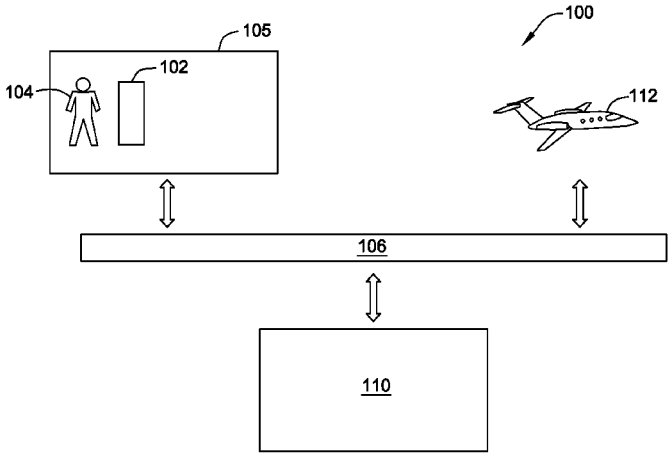
(Continued)

Primary Examiner — Kerri McNally
(74) *Attorney, Agent, or Firm* — Armstrong Teasdale LLP

(57) **ABSTRACT**

A portable device for presenting situation awareness information is provided. The portable device is operable onboard an aircraft and includes a communications module configured to communicate with a data center to receive situation awareness information that includes at least a real-time position for each of a plurality of additional aircraft, a sensor module configured to determine a real-time position of the portable device, and a display device configured to overlay a moving map display with the situation awareness information and the real-time position of the portable device.

18 Claims, 4 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

6,703,945	B2 *	3/2004	Kuntman et al.	340/961
6,795,408	B1 *	9/2004	Hiett	370/323
6,809,679	B2 *	10/2004	LaFrey et al.	342/37
7,090,128	B2 *	8/2006	Farley et al.	235/384
7,209,053	B2 *	4/2007	Gannon	340/972
7,212,917	B2	5/2007	Wilson, Jr. et al.	
7,321,813	B2 *	1/2008	Meunier	701/10
7,330,780	B2	2/2008	Von Viebahn et al.	
7,437,225	B1	10/2008	Rathinam	
7,450,969	B1 *	11/2008	Cockayne	455/566
7,457,690	B2	11/2008	Wilson, Jr. et al.	
7,633,428	B1	12/2009	McCusker et al.	
7,859,433	B2 *	12/2010	Barry et al.	340/945
7,885,733	B1	2/2011	Simon	
8,000,848	B2 *	8/2011	Baranov et al.	701/14
8,005,614	B2 *	8/2011	Dattler et al.	701/412
8,255,094	B2 *	8/2012	Srinivasan et al.	701/3
8,306,528	B2 *	11/2012	Malosh	455/431
8,452,475	B1 *	5/2013	West et al.	701/29.1
8,474,746	B2 *	7/2013	van Helden	244/25
8,509,140	B2 *	8/2013	Kauffman	370/316
8,515,600	B1 *	8/2013	McCusker	701/9
8,532,844	B2 *	9/2013	Wilson et al.	701/3
8,732,233	B2 *	5/2014	Allen	709/203
2002/0021247	A1 *	2/2002	Smith et al.	342/450
2002/0039072	A1 *	4/2002	Gremmert et al.	340/945
2002/0075171	A1 *	6/2002	Kuntman et al.	340/961
2003/0135327	A1	7/2003	Levine et al.	
2004/0048598	A1 *	3/2004	Gagnon	455/404.2
2005/0051615	A1 *	3/2005	Farley et al.	235/375
2005/0270224	A1 *	12/2005	Silberman et al.	342/65
2006/0167598	A1 *	7/2006	Pennarola	701/11
2006/0227014	A1 *	10/2006	Gannon	340/972
2007/0005199	A1 *	1/2007	He	701/16
2007/0055416	A1 *	3/2007	Allen	701/3
2007/0120729	A1 *	5/2007	Barry et al.	342/33
2007/0186000	A1 *	8/2007	Nikander et al.	709/228
2007/0294064	A1 *	12/2007	Shuster	703/3
2008/0046141	A1 *	2/2008	Dattler et al.	701/29
2008/0228330	A1 *	9/2008	Srinivasan et al.	701/3
2009/0082954	A1 *	3/2009	Ridenour, II	701/206
2009/0109065	A1	4/2009	Pinheiro	
2009/0125221	A1	5/2009	Estkowski et al.	
2009/0231163	A1 *	9/2009	He	340/946
2009/0252372	A1 *	10/2009	Davies	382/100
2010/0030401	A1	2/2010	Rogers et al.	
2010/0082184	A1	4/2010	Nichols et al.	
2010/0102163	A1 *	4/2010	Van Helden	244/25
2010/0174475	A1	7/2010	Estkowski et al.	
2010/0274468	A1 *	10/2010	Durham et al.	701/120
2012/0259549	A1 *	10/2012	McDonald	702/3
2013/0013134	A1 *	1/2013	Lieu	701/14
2013/0048782	A1 *	2/2013	Bohlen et al.	244/1 TD

OTHER PUBLICATIONS

FAA Issues InFO Bulletin on Tablet EFB Authorization—Jeppesen Mobile TC for iPad Cited as Example; Jeppeseon—A Boeing Company; May 31, 2011; 2 pages.

Jeppeson Mobile FliteDecl—Frequently Asked Questions; Jeppeson—A Boeing Company; Aug. 18, 2011; 4 pages.

iCub—the LSA Bush Plane; http://icub.aero/?cat=14; accessed Nov. 11, 2011; 7 pages.

European Examination Report of Application No. 12193473.1, Feb. 9, 2015, 8 pages.

* cited by examiner

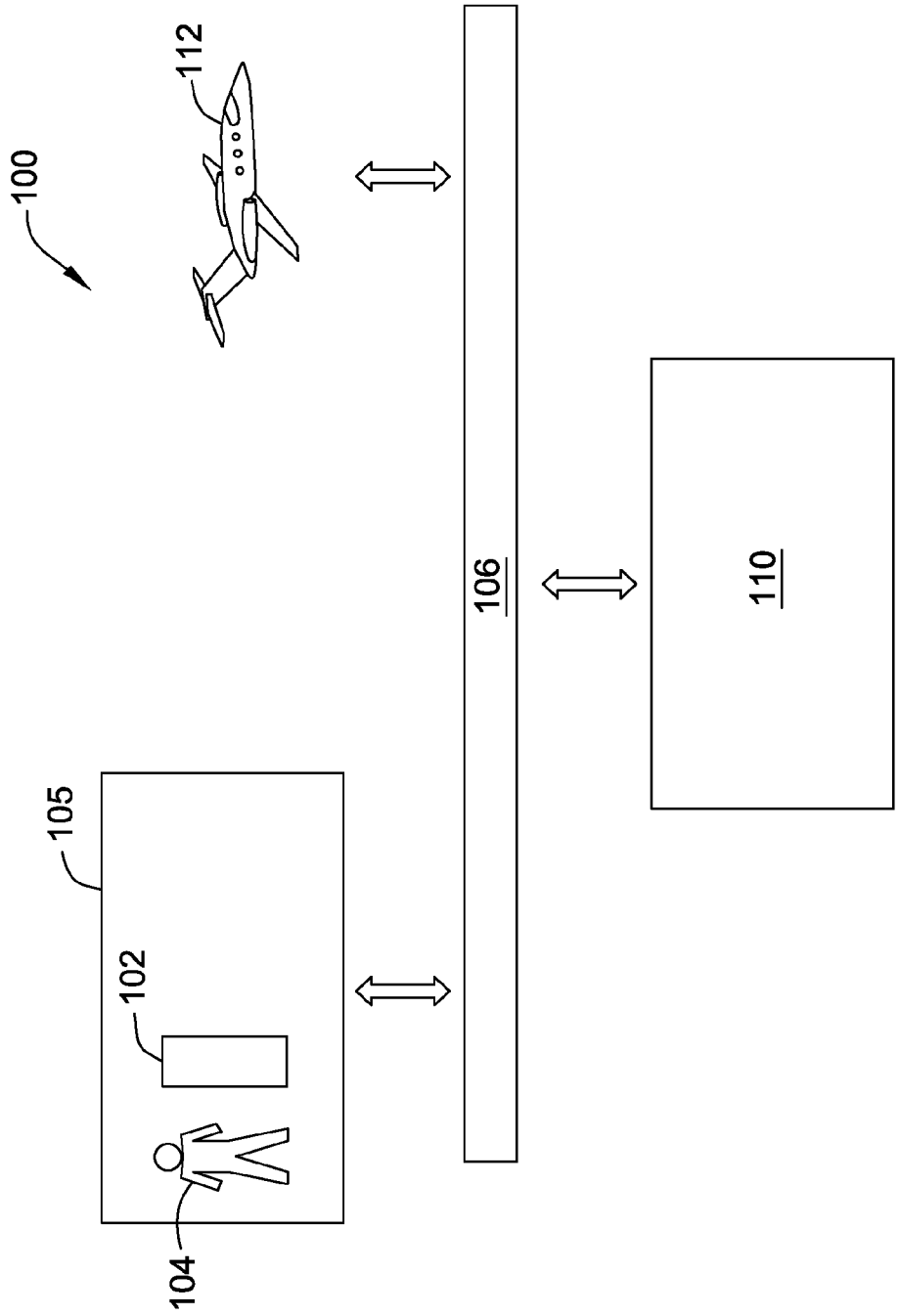


Figure 1

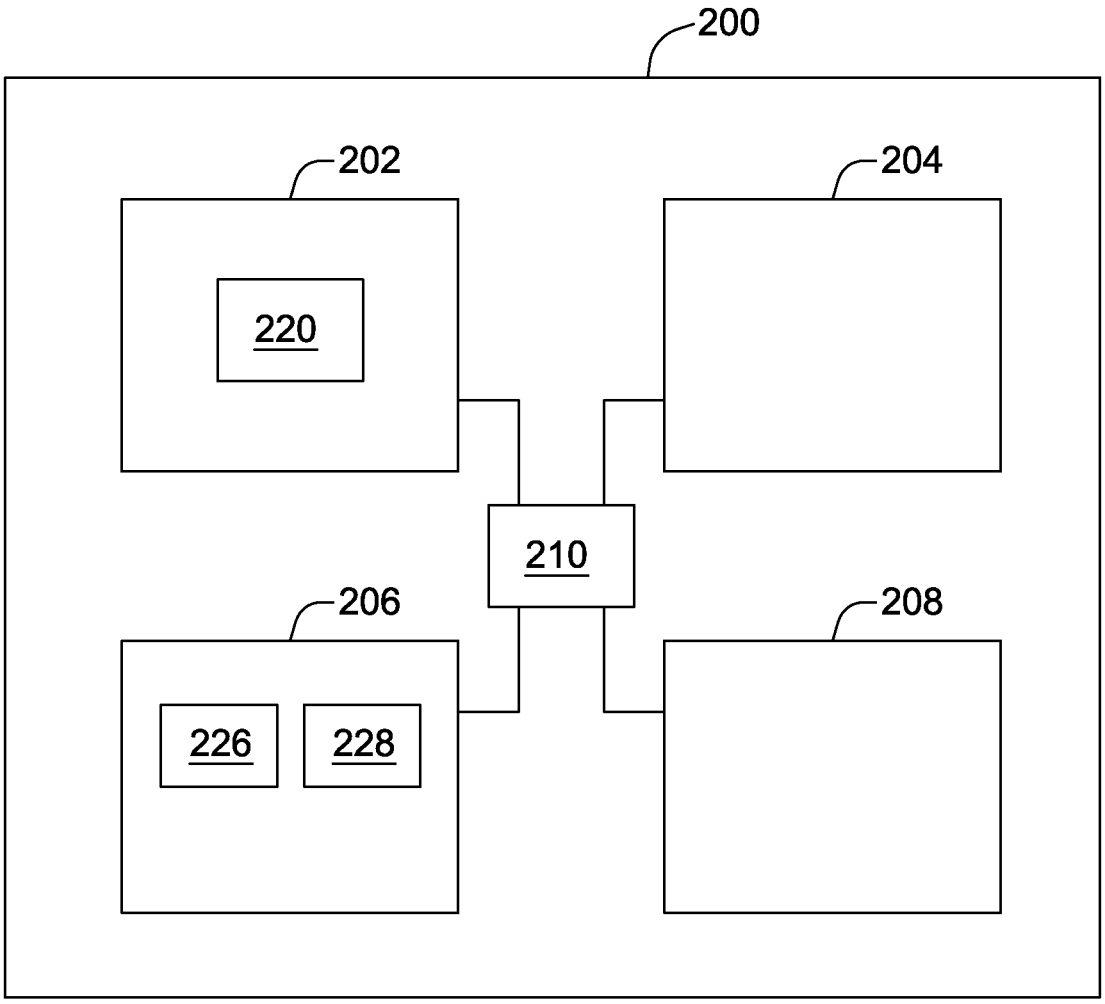


Figure 2

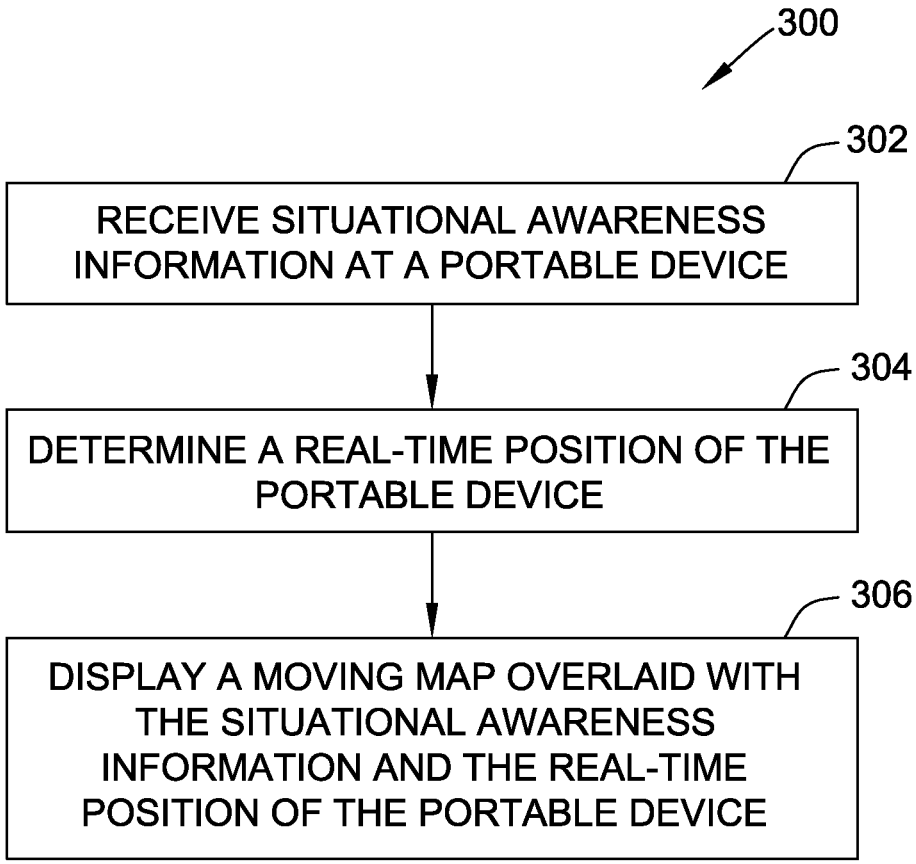

300
302
RECEIVE SITUATIONAL AWARENESS INFORMATION AT A PORTABLE DEVICE
304
DETERMINE A REAL-TIME POSITION OF THE PORTABLE DEVICE
306
DISPLAY A MOVING MAP OVERLAID WITH THE SITUATIONAL AWARENESS INFORMATION AND THE REAL-TIME POSITION OF THE PORTABLE DEVICE

Figure 3

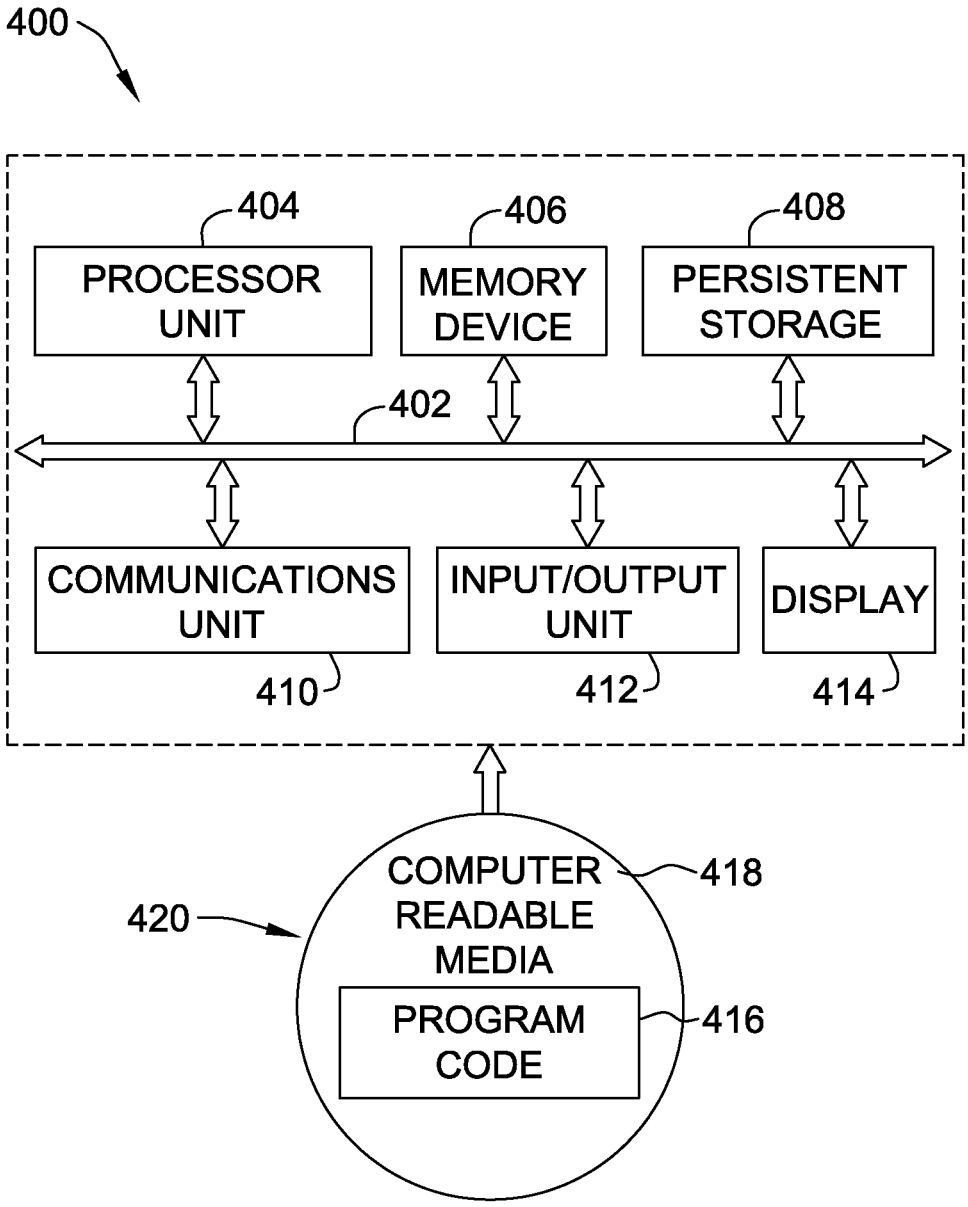

400
404
406
408
PROCESSOR UNIT
MEMORY DEVICE
PERSISTENT STORAGE
402
COMMUNICATIONS UNIT
INPUT/OUTPUT UNIT
DISPLAY
410
412
414
COMPUTER READABLE MEDIA
418
420
PROGRAM CODE
416

Figure 4

SYSTEM AND METHODS FOR SITUATION AWARENESS, ADVISORY, TRACKING, AND AIRCRAFT CONTROL INFORMATION

BACKGROUND

The field of the disclosure relates generally to situation awareness, advisory information, and aircraft control, and more specifically, to portable devices for processing and displaying, and acting on situation awareness information and advisory information.

Pilots use situation awareness information and advisory information when operating aircraft. Unmanned air systems (UAS) automated systems also utilize situation awareness and advisory information. Such information may include the position of the aircraft being operated, the position of additional aircraft, and/or advisory information. Situation awareness information may also include flight plan information, such as suggested routes, waypoints, etc.

At least some known situation awareness systems are fully integrated into their associated aircraft. That is, hardware for at least some situation awareness systems is permanently coupled to various aircraft systems and is mounted within the aircraft. Furthermore, given their complexity and permanent installation, at least some known situation awareness systems are relatively expensive.

Many pilots may be unable and/or unwilling to purchase expensive and cumbersome situation awareness systems. For example, general aviation pilots may be unable to afford situation awareness systems utilized by commercial and/or military pilots. Further, due to their configuration, certain types of aircraft, including but not limited to older aircraft, light sport, gliders, and balloons may be unable to support at least some known situation awareness systems.

At least some known portable devices are unable to display real-time positions of aircraft on moving map displays. Accordingly, at least some known portable devices are unable to present dynamic situation awareness information to a user. Further, at least some known devices that do provide moving map displays and information on traffic require transponder installation and are unable to provide over-the-horizon (non-local) traffic information or traffic flight plan information along an intended ownship route.

BRIEF DESCRIPTION

In one aspect, a portable device for presenting situation awareness information is provided. The portable device is operable onboard an aircraft and includes a communications module configured to communicate with a data center to receive situation awareness information that includes at least a real-time position for each of a plurality of additional aircraft, a sensor module configured to determine a real-time position of the portable device, and a display device configured to overlay a moving map display with the situation awareness information and the real-time position of the portable device.

In another aspect, a method for processing situation awareness information is provided. The method includes receiving, at a portable device operable onboard an aircraft, situation awareness information from a data center, the situation awareness information including at least a real-time position for each of a plurality of additional aircraft, determining a real-time position of the portable device, and displaying, on the portable device, a moving map overlaid with the situation awareness information and the real-time position of the portable device.

In yet another aspect, a method for transmitting a real-time position of an aircraft is provided. The method includes positioning a portable device onboard the aircraft, the portable device including a sensor module and a communications module, determining the real-time position of the aircraft using the sensor module, and transmitting the real-time position of the aircraft from the portable device to a data center using the communications module.

The features, functions, and advantages that have been discussed can be achieved independently in various embodiments or may be combined in yet other embodiments, further details of which can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagram of an exemplary situation awareness system.

FIG. **2** is a block diagram of an exemplary portable device that may be used as part of the system shown in FIG. **1**.

FIG. **3** is a flowchart of an exemplary method for processing situation awareness information that may be used with the system shown in FIG. **1**.

FIG. **4** is a diagram of an exemplary data processing system.

DETAILED DESCRIPTION

The systems and methods described herein facilitate processing and presenting dynamic situation awareness information. A portable device operable onboard an aircraft communicates with a data center to receive situation awareness information, such as the real-time position of other aircraft. The portable device also includes sensors for determining the real-time position of the portable device, and accordingly, the aircraft. The received situation awareness information and the real-time position of the aircraft may be displayed on the portable device. Further, the portable device may also be used to transmit situation awareness information to the data center, the situation awareness information gathered from one or more airborne sensors.

FIG. **1** is a schematic diagram of an exemplary situation awareness system **100**. System **100** includes a portable device **102** that receives and transmits situation awareness information, as described in detail below. A user **104** interacts with and/or operates portable device **102**. As used herein, the term "situation awareness information" may include aircraft position information, flight plan information, weather information and/or advisories, and/or any other data that may be transmitted and/or received within system **100**. Advisories may include, for example, restricted regions and/or routes, and/or suggested reroutes to avoid weather, traffic, and/or terrain.

In the exemplary embodiment, user **104** and portable device **102** are located onboard an aircraft **105**. Alternatively, in embodiments where aircraft **105** is operated remotely, user **104** and/or portable device **102** may not be located onboard aircraft **105**. Additionally, when aircraft **105** is operated remotely, portable device **102** may be onboard aircraft **105** and interface between a control center and an autopilot system of aircraft **105**, as described in detail below. As used herein, the term "aircraft" includes airplanes, unmanned aerial vehicles (UAVs), missiles, ordinance, gliders, helicopters, balloons, and other objects that travel. For a UAV, in some embodiments, portable device **102** may be located at a UAV control station to provided additional and/or redundant situation awareness and/or control mechanisms.

To transmit and receive situation awareness information, portable device **102** communicates with other devices and/or systems over a communications link **106**. In the exemplary embodiment, portable device **102** utilizes communications link **106** to communicate with a ground center **110** and other aircraft **112**. Communications link **106** may include, but is not limited to, a wired and/or wireless network, a satellite network, radio, 3G, 4G, Controller Pilot Data Link Communications (CPDLC), and Tactical Digital Information Links (TADIL). In some embodiments, portable device **102** may communicate different types of data using different communication links **106**. For example a 3G link may have a lower link latency, lower dropout rate, etc. In some embodiments, portable device **102** may also simultaneously communicate over multiple communication links **106** and/or to multiple receiving entities in order to improve communications reliability.

Ground center **110** functions as a data center for portable device **102** and may include an automated dynamic airspace control (ADAC) center, an air route traffic control center (ARTCC), an airport-based control tower, a terminal radar approach control (TRACON) center, and/or a flight service station (FSS). Alternatively, ground center **110** includes any control center that enables system **100** to function as described herein. Ground center **110** manages situation awareness information, generates trajectory predictions for aircraft **105** and **112**, and generates and transmits reroute commands and/or advisories to aircraft **105** and **112**. While in the exemplary embodiment, portable device **200** communicates with ground center **110**, alternatively, portable device **200** communicates with any data center that enables system **100** to function as described herein. For example, portable device **200** may communicate with a data center onboard another aircraft, ship, or satellite, and/or distributed across multiple entities.

FIG. **2** is a block diagram of a portable device **200** that may be used as part of system **100** (shown in FIG. **1**), such as portable device **102**. In the exemplary embodiment, portable device **200** is a tablet computer. Alternatively, portable device **200** may be any portable device that enables system **100** to function as described herein. Portable device **200** includes a sensor module **202**, a communications module **204**, a user interface module **206**, and an external device interface module **208**. A processing module **210** is coupled to sensor module **202**, communications module **204**, user interface module **206**, and external device interface module **208**. Processing module **210** processes data for at least one of sensor module **202**, communications module **204**, user interface module **206**, and external device interface module **208**.

In the exemplary embodiment, sensor module **202** includes a global positioning system (GPS) sensor **220**. GPS sensor **220** determines geopositional information for portable device **200**, and accordingly, geopositional information for aircraft **105** when portable device **200** is onboard aircraft **105**. Geopositional information may include, for example, the current latitude, longitude, and/or altitude of portable device **200**. The geopositional information may be calculated, for example, by communicating with satellites using communications module **204**. Based on the geopositional information, using processing module **210**, portable device **200** may calculate a predicted trajectory for aircraft **105** that may be displayed on portable device **200** and/or transmitted to ground center **110** (shown in FIG. **1**).

Sensor module **202** may also include additional sensors, such as a camera, a gyroscope, and altimeter, a barometer, an accelerometer, and/or any sensor that enables portable device **200** to function as described herein. In embodiments where sensor module **202** includes multiple sensors, portable device **200** may combine and analyze input from multiple sensors using, for example, processing module **210**. Additionally, portable device may receive and/or process supplemental sensor data from external sensor modules.

Communications module **204** transmits and receives data for portable device **200**. Using communications module **204**, data may be transmitted and received from ground center **110** and other aircraft **112** for example, using communications link **106** (all shown in FIG. **1**). Communications module **204** transmits and receives data using any suitable communications medium, including, but not limited to, a wired and/or wireless network, an Iridium satellite network, radio, 3G, Controller Pilot Data Link (CPDL), and Tactical Digital Information Links (TADIL). Moreover, in the exemplary embodiment, communications module **204** is capable of over-the-horizon communication of data. Further, communications module **204** is capable of communicating over multiple communications networks for an increased response time. Data transmitted and/or received by communications module **204** includes situation awareness information from ground center **110**, geopositional information from GPS sensor **220**, messages from user **104** input using user interface module **206**, and/or any other types of data that enable portable device **200** to function as described herein. Communications module **204** may include an expanded data receiving capability, such as a stackable bus system, an expanded data processing capability, and/or an expanded data translation capability.

While in the exemplary embodiment, communications module **204** is part of portable device **200**, alternatively, communications module **204** may be external to portable device **200**. In embodiments where communications module **204** is external to portable device **200**, communications module **204** and portable device **200** interface using any suitable medium including, but not limited to, a wireless network and/or a physical cable.

In the exemplary embodiment, communications module **204** transmits geopositional information from GPS sensor **220** to ground center **110**. Geopositional information may be transmitted to ground center **110** continuously or periodically. The transmitted geopositional information provides basic tracking data for aircraft **105** to ground center **110**. Ground center **110** can utilize the geopositional information to update situation awareness information, generate trajectory predictions for aircraft **105**, and/or generate and transmit reroute commands to aircraft **105** and/or other aircraft **112**. Accordingly, portable device **200** may provide tracking data to ground center **110** without the use of additional GPS or automatic dependent surveillance broadcast (ADS-B) systems.

Communications module **204** also receives situation awareness information from ground center **110** and/or other aircraft **112**. In the exemplary embodiment, communications module **204** receives position and trajectory information for other aircraft **112**. The received position and trajectory information may be displayed for user **104** using user interface module **206**.

User interface module **206** includes an input device **226**, such as a touchscreen, keypad and/or keyboard, and/or mouse that enables user **104** to enter information and interact with portable device **200**. Using input device **226**, user **104** can input one or more alerts. Such alerts may include weather advisories, flocks of birds, and/or the locations of thermals, turbulence, and/or control towers. Additionally, the alerting system may also serve as a timely incident reporting system. Using communications module **204**, an input alert may be

transmitted to ground center **110** for distribution to other aircraft **112**. User **104** may also utilize user interface module **206** to input and send messages to an operator at ground center **110** regarding the status of aircraft **105**. User **104** may also communicate information to any data processing center, control center, or aircraft owner entity that enables system **100** to function as described herein.

User interface module **206** also includes a display device **228** that enables user **104** to view situation awareness information. In the exemplary embodiment, display device **228** displays a moving map overlaid with dynamic situation awareness information. The moving map may include terrain data, elevation data, and/or any other information that enables display device **228** to function as described herein. Moreover, data associated with the moving map may be stored on portable device **200** and/or streamed and/or received from other sources. For example, map data may be received from ground center **110** using communications module **204**. Portable device **200** receives situation awareness information from one or more source and displays the situation awareness information on display device **228**.

In the exemplary embodiment, situation awareness information includes an own ship depiction that shows the real-time position of aircraft **105** on the moving map. Flight plan data for aircraft **105**, such as waypoints and/or other symbols may be shown on display device **228**. A depiction and position of other aircraft, such as aircraft **112** may also be shown on display device **228**. Situation awareness displayed on display device **228** may include any other information that enables portable device **200** to function as described herein. For example, information associated with weather advisories, flocks of birds, and/or the locations of thermals, turbulence, and/or control towers may be displayed on display device **228**.

In the exemplary embodiment, portable device **200** determines the real-time position of aircraft **105** using GPS module **220**. Alternatively, portable device **200** may interface with one or more external devices to determine the real-time position of aircraft **105**. For example, portable device **200** may interface with an external GPS device onboard aircraft **105**.

Flight plan data for aircraft **105** may be stored on portable device **200**, or may be received from ground center **110** via communications module **204**. If ground center **110** transmits one or more reroute commands to portable device **200**, the flight plan data shown on display device **228** is updated accordingly. For example, after a reroute command is received from ground center **110**, updated waypoints may be shown on display device **228**. Portable device **200** may also verify the validity, safety, and/or feasibility of a reroute command received from ground center **110** using processing module **210**. Moreover, in some embodiments, a plurality of route options and information associated with each route option (e.g., time, distance, fuel requirements, etc.) may be shown on display device **228**.

Portable device determines the real-time position of other aircraft **112** by communicating with ground center **110** using communications module **204** in the exemplary embodiment. That is, other aircraft **112** transmit associated real-time position information to ground center **110**, which in turn relays the information to portable device **200**. Alternatively, portable device **200** may determine the real-time position of other aircraft **112** by communicating directly with other aircraft **112**.

External device interface module **208** enables portable device **200** to interface and/or communicate with one or more external devices (not shown) onboard aircraft **105**. Such external devices include, but are not limited to, an autopilot system, an air data system, a satellite modem, a GPS device, a cellular modem, a radio, a sensor system, a radar system, and/or an ADS-B system. Accordingly, in some embodiments, portable device **200** may receive information from such external devices.

In order to interface with the external devices, external device interface module **208** includes suitable hardware, such as converters and/or adaptors. For example, in one embodiment, external device interface module **208** includes a serial adaptor and a wireless network adaptor. While in the exemplary embodiment, external device interface module **208** is separate from communications module **204**, in some embodiments, external device interface module **208** is part of communications module **204**. Further, in some embodiments, external device interface module **208** is a separate component from portable device **200**.

Using external device interface module **208**, portable device **200** may interface directly with an autopilot system to control aircraft **105**. Specifically, flight plan data for aircraft **105** may be stored and/or received at portable device **200**, as described above. Portable device **200** supplies the received flight plan data to the autopilot system, and the autopilot system utilizes the flight plan data to perform control maneuvers to control flight of aircraft **105**. To interface directly with the autopilot system, portable device **200** may interface directly with a bus on which the autopilot system is directly connected. Alternatively, portable device **200** may have a direct digital and/or analog connection to an autopilot and/or steering/control system that is not connected to a bus.

As such, in some embodiments, portable device **200** may be used in conjunction with an unmanned aerial vehicle (UAV) to receive flight plan information and pilot the UAV in accordance with the flight plan information. Furthermore, in some embodiments, communications module **204** may be configured to receive routing commands from a data center, such as ground center **110**, and external device interface module **208** is further configured to supply routing commands to the autopilot system. In many embodiments, communications module **204** is further configured to receive routing commands from the data center, and display device **228** is further configured to update one or more displayed waypoints based on the routing commands. In some embodiments, portable device **200** receives routing commands from the data center and supplies the routing commands to the autopilot system of aircraft **105**, and portable device is located onboard an unmanned aerial vehicle. Accordingly, portable device **200** may operate with or without user **104** onboard aircraft **105**.

FIG. **3** is a flowchart of an exemplary method **300** for processing situation awareness information that may be used with system **100** (shown in FIG. **1**). Method **300** includes receiving **302** situation awareness information at a portable device, such as portable device **200** (shown in FIG. **2**). The portable device is located onboard an aircraft, such as aircraft **105** (shown in FIG. **1**). Moreover, the situation awareness information includes at least a real-time position of a plurality of aircraft, such as other aircraft **112** (shown in FIG. **1**).

Method **300** further includes determining **304** a real-time position of the portable device. As the portable device is located onboard the aircraft, the real-time position of the portable device corresponds to the real-time position of the aircraft. The real-time position of the portable device may be determined using, for example, a GPS sensor, such as GPS sensor **220** (shown in FIG. **2**).

A moving map is displayed **306** on a display device, such as display device **228** (shown in FIG. **2**). The moving map is overlaid with the situation awareness information and the real-time position of the portable device. Accordingly, a user,

such as user **104**, may use the portable device to view a real-time position of the aircraft on which the portable device is located, as well as a real-time position of other aircraft.

FIG. **4** is a diagram of an exemplary data processing system **400** that may be used in implementing one or more of the embodiments described herein. For example, portable device **200**, sensor module **202**, communications module **204**, user interface module **206**, external device interface module **208**, and/or processing module **210** may be implemented using data processing system **400**. In the exemplary embodiment, data processing system **400** includes communications fabric **402**, which provides communications between processor unit **404**, memory **406**, persistent storage **408**, communications unit **410**, input/output (I/O) unit **412**, and display **414**.

Processor unit **404** serves to execute instructions for software that may be loaded into memory **406**. Processor unit **404** may be a set of one or more processors or may be a multi-processor core, depending on the particular implementation. Further, processor unit **404** may be implemented using one or more heterogeneous processor systems in which a main processor is present with secondary processors on a single chip.

As another illustrative example, processor unit **404** may be a symmetric multi-processor system containing multiple processors of the same type. Further, processor unit **404** may be implemented using any suitable programmable circuit including one or more systems and microcontrollers, microprocessors, reduced instruction set circuits (RISC), application specific integrated circuits (ASIC), programmable logic circuits, field programmable gate arrays (FPGA), and any other circuit capable of executing the functions described herein.

Memory **406** and persistent storage **408** are examples of storage devices. A storage device is any piece of hardware that is capable of storing information either on a temporary basis and/or a permanent basis. Memory **406**, in these examples, may be, for example, without limitation, a random access memory or any other suitable volatile or non-volatile storage device. Persistent storage **408** may take various forms depending on the particular implementation.

For example, without limitation, persistent storage **408** may contain one or more components or devices. For example, persistent storage **408** may be a hard drive, a flash memory, a rewritable optical disk, a rewritable magnetic tape, or some combination of the above. The media used by persistent storage **408** also may be removable. For example, without limitation, a removable hard drive may be used for persistent storage **408**. Persistent storage **408** may also include so-called "cloud" storage.

Communications unit **410**, in these examples, provides for communications with other data processing systems or devices. In these examples, communications unit **410** is a network interface card. Communications unit **410** may provide communications through the use of either or both physical and wireless communication links.

Input/output unit **412** allows for input and output of data with other devices that may be connected to data processing system **400**. For example, without limitation, input/output unit **412** may provide a connection for user input through a keyboard and mouse. Further, input/output unit **412** may send output to a printer. Display **414** provides a mechanism to display information to a user.

Instructions for the operating system and applications or programs are located on persistent storage **408**. These instructions may be loaded into memory **406** for execution by processor unit **404**. The processes of the different embodiments may be performed by processor unit **404** using computer implemented instructions, which may be located in a memory, such as memory **406**. These instructions are referred to as program code, computer usable program code, or computer readable program code that may be read and executed by a processor in processor unit **404**. The program code in the different embodiments may be embodied on different physical or tangible computer readable media, such as memory **406** or persistent storage **408**.

Program code **416** is located in a functional form on computer readable media **418** that is selectively removable and may be loaded onto or transferred to data processing system **400** for execution by processor unit **404**. Program code **416** and computer readable media **418** form computer program product **420** in these examples. In one example, computer readable media **418** may be in a tangible form, such as, for example, an optical or magnetic disc that is inserted or placed into a drive or other device that is part of persistent storage **408** for transfer onto a storage device, such as a hard drive that is part of persistent storage **408**. In a tangible form, computer readable media **418** also may take the form of a persistent storage, such as a hard drive, a thumb drive, or a flash memory that is connected to data processing system **400**. The tangible form of computer readable media **418** is also referred to as computer recordable storage media. In some instances, computer readable media **418** may not be removable.

Alternatively, program code **416** may be transferred to data processing system **400** from computer readable media **418** through a communications link to communications unit **410** and/or through a connection to input/output unit **412**. The communications link and/or the connection may be physical or wireless in the illustrative examples. The computer readable media also may take the form of non-tangible media, such as communications links or wireless transmissions containing the program code.

In some illustrative embodiments, program code **416** may be downloaded over a network to persistent storage **408** from another device or data processing system for use within data processing system **400**. For instance, program code stored in a computer readable storage medium in a server data processing system may be downloaded over a network from the server to data processing system **400**. The data processing system providing program code **416** may be a server computer, a client computer, or some other device capable of storing and transmitting program code **416**.

The different components illustrated for data processing system **400** are not meant to provide architectural limitations to the manner in which different embodiments may be implemented. The different illustrative embodiments may be implemented in a data processing system including components in addition to or in place of those illustrated for data processing system **400**. Other components shown in FIG. **4** can be varied from the illustrative examples shown.

As one example, a storage device in data processing system **400** is any hardware apparatus that may store data. Memory **406**, persistent storage **408** and computer readable media **418** are examples of storage devices in a tangible form.

In another example, a bus system may be used to implement communications fabric **402** and may be comprised of one or more buses, such as a system bus or an input/output bus. Of course, the bus system may be implemented using any suitable type of architecture that provides for a transfer of data between different components or devices attached to the bus system. Additionally, a communications unit may include one or more devices used to transmit and receive data, such as a modem or a network adapter. Further, a memory may be, for example, without limitation, memory **406** or a cache such as that found in an interface and memory controller hub that may be present in communications fabric **402**.

The embodiments described herein facilitate processing and presenting dynamic situation awareness information. A portable device operable onboard an aircraft communicates with a data center to receive situation awareness information, such as the real-time position of other aircraft. The portable device also includes sensors for determining the real-time position of the portable device, and accordingly, the aircraft. The received situation awareness information and the real-time position of the aircraft may be displayed on the portable device. Further, the portable device may also be used to transmit situation awareness information to the data center, the situation awareness information gathered from one or more airborne sensors.

The systems and methods described herein prove a pilot and/or autopilot of an aircraft with real-time, in-flight, and/or over-the-horizon situation awareness information and advisory information, such as, for example, traffic safety advisory information. Further, the systems and methods described herein may be implemented using existing network technology. Moreover, the embodiments described herein may be implemented using relatively inexpensive portable devices, such as, for example, tablet computers and/or smart phones.

Unlike at least some known situation awareness systems and methods, because the systems and methods described herein utilize a portable device, the systems and methods described herein are relatively inexpensive and accessible. Furthermore, unlike at least some known situation awareness systems, the portable device need not be permanently installed within an aircraft. Further, the portable device may be utilized to process and present situation awareness information for aircraft that are unable to support at least some known situation awareness systems. Moreover, unlike at least some known portable device, the described systems utilize networked information instead of solely relying on local information obtained from line-of-site short-range sensors and transponders.

The embodiments described herein may utilize executable instructions embodied in a computer readable medium, including, without limitation, a storage device or a memory area of a computing device. Such instructions, when executed by one or more processors, cause the processor(s) to perform at least a portion of the methods described herein. As used herein, a "storage device" is a tangible article, such as a hard drive, a solid state memory device, and/or an optical disk that is operable to store data.

Although specific features of various embodiments of the invention may be shown in some drawings and not in others, this is for convenience only. In accordance with the principles of the invention, any feature of a drawing may be referenced and/or claimed in combination with any feature of any other drawing.

This written description uses examples to disclose various embodiments, which include the best mode, to enable any person skilled in the art to practice those embodiments, including making and using any devices or systems and performing any incorporated methods. The patentable scope is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A portable device for presenting situation awareness information, said portable device operable onboard an aircraft and comprising:

a communications module configured to communicate with a data center to receive situation awareness information and routing commands from the data center, wherein the situation awareness information includes at least a real-time position for each of a plurality of additional aircraft;

an external device interface module configured to supply the routing commands received from the data center to an autopilot system of the aircraft;

a sensor module configured to determine a real-time position of said portable device; and

a display device configured to overlay a moving map display with the situation awareness information and the real-time position of said portable device, wherein said portable device is a tablet computer.

2. A portable device in accordance with claim **1**, wherein said portable device is located onboard an unmanned aerial vehicle.

3. A portable device in accordance with claim **1**, wherein said situation awareness information includes at least one of an advisory, a warning, and a route command.

4. A portable device in accordance with claim **1**, wherein said portable device further comprises a user interface module configured to receive at least one alert from a user.

5. A portable device in accordance with claim **1**, wherein said communications module is configured to receive situation awareness information that includes weather advisories, and wherein said display device is configured to display received weather advisories.

6. A portable device in accordance with claim **1**, wherein said communications module is further configured to transmit the real-time position of said portable device to the data center, and wherein the data center is one of an automated dynamic airspace control center, an air route traffic control center, an airport-based control tower, a terminal radar approach control system, or a flight service station.

7. A portable device in accordance with claim **1**, wherein said display device is further configured to display a plurality of waypoints corresponding to a flight plan of the aircraft.

8. A portable device in accordance with claim **7**, wherein said display device is further configured to update the displayed plurality of waypoints based on the routing commands received from the data center.

9. A method for processing situation awareness information, said method comprising:

receiving, at a portable device operable onboard an aircraft, situation awareness information and routing commands from a data center, the situation awareness information including at least a real-time position for each of a plurality of additional aircraft;

supplying the routing commands received from the data center to an autopilot system of the aircraft;

determining a real-time position of the portable device; and

displaying, on the portable device, a moving map overlaid with the situation awareness information and the real-time position of the portable device, wherein the portable device is a tablet computer.

10. A method in accordance with claim **9**, further comprising:

verifying, at the portable device, the validity of the routing commands, wherein the portable device is located onboard an unmanned aerial vehicle.

11. A method in accordance with claim **9**, wherein determining a real-time position of the portable device comprises determining the real-time position of the portable device using a global positioning system sensor.

12. A method in accordance with claim 9, wherein receiving situation awareness information comprises receiving situation awareness information that includes locations of at least one of flocks of birds, thermals, turbulence, and control towers.

13. A method in accordance with claim 9, further comprising displaying, on the portable device, a plurality of waypoints corresponding to a flight plan of the aircraft.

14. A method in accordance with claim 13, further comprising:

updating the displayed plurality of waypoints based on the routing commands, wherein the data center is located onboard another aircraft.

15. A method for transmitting a real-time position of an aircraft comprising:

positioning a portable device onboard the aircraft, the portable device including a sensor module and a communications module;

determining the real-time position of the aircraft using the sensor module;

transmitting the real-time position of the aircraft from the portable device to a data center using the communications module, wherein the portable device is a tablet computer;

receiving, at the portable device, routing commands from the data center; and

supplying the routing commands received from the data center to an autopilot system of the aircraft.

16. A method in accordance with claim 15, further comprising:

receiving, at the portable device, situation awareness information from a user onboard the aircraft; and

transmitting the situation awareness information from the portable device to the data center using the communications module.

17. A method in accordance with claim 15, wherein receiving situation awareness information comprises receiving one or more alerts.

18. A method in accordance with claim 15, wherein determining the real-time position of the aircraft comprises determining a real-time position of the portable device using a global positioning system sensor.

* * * * *